Minimally Intrusive Embedded Sensors for High Mass to Mars Thermal Protection Systems

Completed Technology Project (2017 - 2018)

Project Introduction

The safety and overall mission success of space vehicles rely heavily on the integrity of the TPS to protect valuable payload during atmospheric entry. Future missions would comprise of humans, life supporting infrastructures, and robotic builders. Therefore, it is imperative to sufficiently and efficiently monitor the health of the TPS by way of large area coverage of the surface with miniature, low weight, and minimally intrusive instrumentation. Previous studies estimated that the payload could be as large as 80 mt while the entry mass could be three times higher. This implies that the recession rate of the TPS material must be adequately quantified at a higher fidelity beyond the current state of the art (SoA) Mars Science Laboratory Entry Descent and Landing Instrumentation (MEDLI-2) planned for use in the Mars2020 TPS. A significant mass reduction of the entry vehicle is anticipated, thereby reducing $/lb launch cost and retaining of payload weight. This is with the goal of achieving the prescribed 50% mass reduction. The goal is to provide high fidelity real-time monitoring of vehicle health during atmospheric entry.

Anticipated Benefits

We have identified the following missions as potential beneficiaries of this technology: The Orion Crew Exploration Vehicle, Discovery 14 (Needed by 2020), Mars Sample Return (Needed by 2023), and DRM 9 Crewed Mars Surface Mission (Needed by 2027). Damage to materials due to use and environmental conditions is problematic in many industries. Corrosion, ablation, attrition and erosion are examples of material damage that effect industrial applicability and use, resulting in increased maintenance costs, compromised safety, higher production costs and other negative results. In order to mitigate this damage, corrosion monitoring is necessary. Potential commercial applications of this technology have been identified, specifically in the fracking industry.

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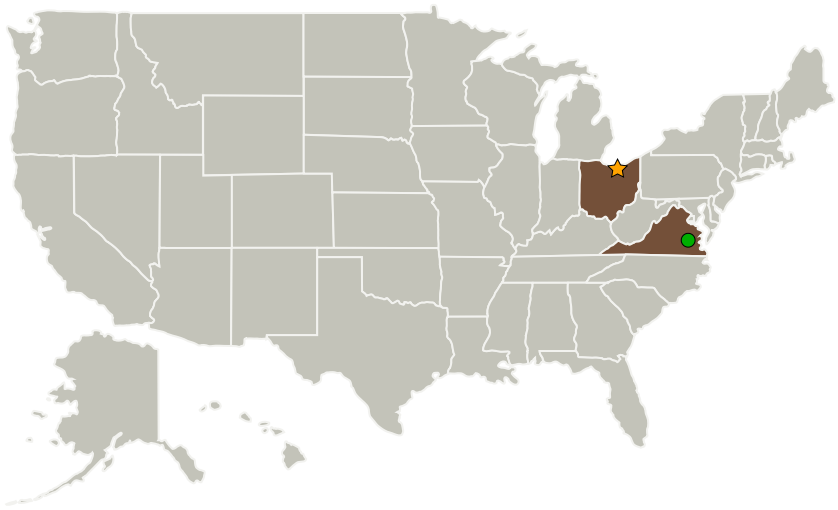
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Innoveering LLC	Supporting Organization	Industry	
●Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Ohio	Virginia

Project Transitions

October 2017: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Center Innovation Fund: GRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Managers:

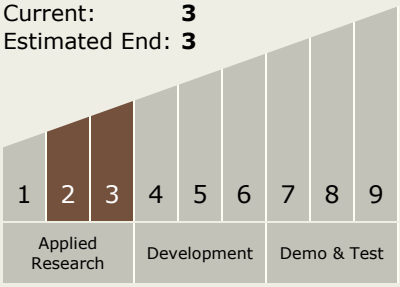
Kurt R Sacksteder
Gary A Horsham

Principal Investigator:

Robert S Okojie

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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September 2018: Closed out

Closeout Summary: The goal of this project was to provide high fidelity real-time health monitoring of vehicle thermal protection systems (TPS) during atmospheric entry or re-entry. The project demonstrated ease of insertion of the sensors in the TPS material without compromising TPS structural integrity. The technology started at a TRL 1 level and ended at TRL 3. Further technology maturation process would commence with discussion with HEOMD after submission of the final report. The relevant SMD and HEOMD mission programs would be kept abreast of the progress being made and the identification of further technology development to raise the TRL. The next step would be to test a less thermally conductive material substrate and demonstrate improved measurement fidelity over the MEDLI (Mars Entry, Descent and Landing Instrumentation)-class State of the Art (SoA) TPS instrumentation.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VC

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

Earth, Mars